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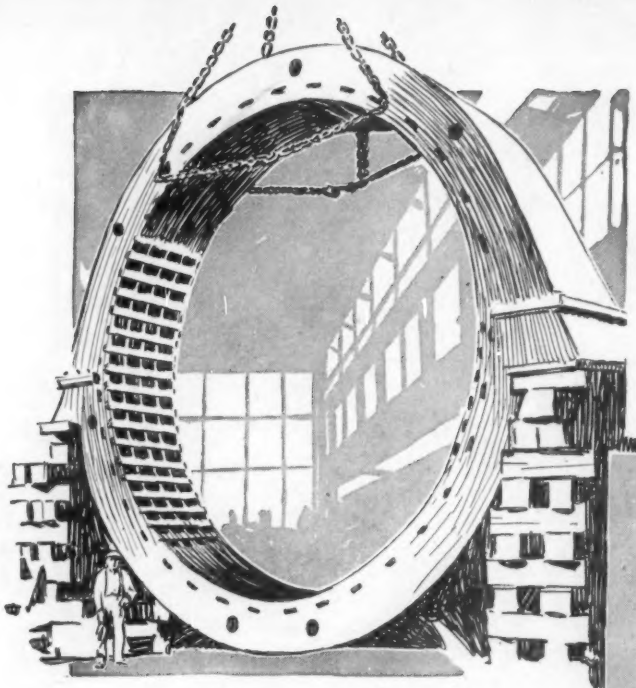

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PREVIEW

SENIORS, and others who find the employment situation in America uninviting, may well heed the advice of Mr. C. T. Brady who discusses in his article "Opportunities in the Argentine?" the difficulties which beset the young engineering graduate in foreign countries. Mr. Brady, who has had twenty years experience in Argentina, and who is now General Manager of The United States Steel Corporation in Buenos Aires, paints a not-too-glowing picture, but he has carefully emphasized the prerequisites for success in that country. In particular he recommends a broad grasp of engineering principles, rather than specialization, and a thorough knowledge of Spanish. Other articles on the foreign situation will appear herein, as soon as they are received from the authors.

SENIORS, again, may raise their eyebrows at the mention, in the same breath, of Fourth Dimension, and Class of 1935. The article by Charles Sutton, a freshman at the Institute, on the "Geometry of the Fourth Dimension" is nevertheless one of the most interesting and best written student articles ever to appear in THE TECH ENGINEERING NEWS. Mr. Sutton, who conceived his liking for higher mathematics in high school under the guidance of a gifted instructor, has not only a thorough grasp of his subject, but a penetrating style.

THE makings of a successful career based on preparation in college are discussed by Mr. R. I. Rees, of the Bell Telephone organization, in his article (page eight). By the use of statistical analyses which have been compiled in that organization, he makes clear among other things that the earning of college expenses has little to do with the success of the earner, contrary to popular opinion. Scholarship and campus activity, moreover, are not as reliable indices as they are commonly supposed to be, though their effect is evident.

STRIP COAL MINING, one of the more popular industries with "wildcat 'security' salesmen and stock jobbing activities" is described by Mr. John A. Garcia, a mining engineer who has had considerable experience in this field. Aside from the description of the problems of the engineer in prospecting and operating a strip coal mine, the effort of the author to discourage the public belief that "a strip coal proposition" is a sure money maker is noteworthy. Strip mining, for the benefit of those not in Course III, consists of uncovering the ore and loading it onto cars. But, as the article makes clear, it is not as simple as that.

IN the vanguard of those experimenting with the use of welding for structural purposes (as against riveting) is the Watertown Arsenal of the United States Army. William L. Warner, the author of the article "Welding for Modern Structures," has, since 1922, been actively engaged in the development of welding, with the General Electric Company, and at Watertown. His discussion represents, therefore, a most up-to-date treatment of a subject which is becoming increasingly important to every branch of engineering.

THE frontispiece, reproduced by special permission of *The American Architect*, is one of a series of interesting illustrations which appeared recently in that magazine.

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Samuel Gottscho in the American Architect

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VOLUME XIII | FEBRUARY 1932 | NUMBER 1

OPPORTUNITIES IN THE ARGENTINE?

By C. T. BRADY

General Manager United States Steel Corporation, Buenos Aires

Past President American Chamber of Commerce in the Argentine

WHEN some young American engineer comes into my office in Buenos Aires looking for work, the first question I ask him is, "How well do you speak Spanish?" Unless the answer is "Fluently," I have to advise him to go back to the United States, for in times like the present — when there is so little of any work to be had by anybody — there is almost no chance whatever that he could find employment, even at wretched wages. There are already too many competent men who can speak the language, and who are on the lookout for any opening. Not only engineers, but other newcomers also have the same troubles, and quite often the Americans resident here have had to contribute to send some fellow countryman back home.

In this article, the second of a series describing the conditions which face the young engineering graduate in foreign countries, Mr. Brady gives TECH ENGINEERING NEWS *readers the benefit of his twenty years' experience in the Argentine. At a time when the employment problem is so acute, the advice of a man as well qualified as he should prove of great value. The third article will appear in an early issue.*
—Editor.

The usual young American, who has not travelled very much, has no real conception of the language difficulty, for in his own country, where everybody — foreigners and all — speaks English, at least after a fashion, he is never forced to contend with this handicap. He has no backing of experience to help him out, such as young Europeans enjoy as a general rule. The man without a knowledge of the language is helpless to explain, or direct, or read a note on a drawing, or write an order, and nobody, to put it quite frankly, has any time or inclination to teach him, or give him the opportunity of "picking up" the language on the job. There is a lot of confidence in young men's minds about this "picking-up" business, but it is in fact a long, hard process and in all cases must be accompanied by tedious and serious study of grammar. Recent arrivals often suppose that they will take board with Spanish-speaking families, and thus acquire the language easily and quickly. Well, in twenty years of residence here, I haven't seen a single instance of the success of this scheme. The importance of the language in one's daily occupation is no doubt obvious, but on reflection it will be seen no less so in regard to the mere routine of living, of getting about the country, of diversions, and so on. There is no wall blanker than not being able to talk to one's neighbors.

Again, few American engineers visualize the competition they must face in coming to this country with the hope of finding employment here. Not only are there the graduates of the various Argentine universities, who, of course, get all the official and Government jobs (and it is to be remembered that the State operates many industries which are left to private enterprise in the United States), but there are many keen young Europeans of every nationality, who are in much better position with respect to the language, and who frequently are, or have been, content with smaller salaries. Besides this, most engineering jobs of any size are built for some public service corporation, or transportation company, who will always prefer to employ — if they have not actually the necessary men here already, or have brought them out specially — engineers of their own nationality. Thus, most of the railroads are English and their engineers are Englishmen; the two great electric plants of Buenos Aires are in the hands of Italian and German engineers, the port of Rosario is under French administration, some of the largest contracting firms are German, contractors for small jobs are often Italians, and so on. There are various industrial and electric and telephone enterprises controlled by American capital, as well as a street-paving company and a branch of a well-known American contracting company which has just finished a new subway, and there are, of course, many American manufacturers of goods or appliances used in engineering who employ engineer-salesmen. All of the engineers for these enterprises, just as in the case of the other nationalities, are sent out from the United States, and are not taken on here. Indeed, there is scarcely a single job of any importance where the employers have not chosen in their own country among suitable candidates, known to them there, one whom they could send out. The ever present language obstacle has been duly considered and the employers have arranged for interpreters, etc., which they would never do for a local man.

In former years many young engineers, of every nationality, did come here "on spec," and as times were booming, they sometimes found small jobs which tided them over while they studied local conditions thoroughly and learned to speak the language. Occasionally such jobs did lead to something better, but often their work had little or nothing to do with engineering, as they took

(*Continued on page 20*)

THE GEOMETRY OF THE FOURTH DIMENSION

By CHARLES S. SUTTON '35

THE "fourth dimension" is a mystery to most people because it lies outside the range of their experience. We measure the surface of a table top by two dimensions — length and width — and the volume of a box by three dimensions — length, width, and depth — but we never have need of more than three. The three dimensions with which we are familiar are homologous: each one is at right angles to each of the other two. Making use of this property, we may define dimensions as directions of measurement which are mutually perpendicular. We know that this definition holds good for the three familiar dimensions, and we shall assume that it holds good for four. We cannot prove that this assumption is true, in fact, we cannot even prove that a fourth dimension exists, but if it does exist, then the above assumption is certainly the simplest and most logical one that we can make. Applying this definition to four dimensions, we see that the direction of the fourth dimension must be at right angles to each of the other three. This is impossible to visualize, since our senses are limited to a perception of three dimensions (to convince yourself, try to hold a pencil at right angles to each of the three edges of a rectangular box), but this does not disprove the existence of a fourth dimension. In this paper we shall derive from the definition the properties of a four dimensional space.

It is important that the reader should approach the subject of the fourth dimension with an open mind; otherwise, he is liable to seal the fate of the question beforehand by his own conviction that, because a thing cannot be visualized, it is impossible. As has been previously implied, the mere fact that something is not apparent to the senses does not preclude its existence. Every day new realities are discovered in the field of science, yet before their discovery, they are, to most people, "impossible." How could the cave man conceive of such a thing as radio? To him, the limit of voice transference was only a few hundred yards; how, then, could a man be heard for thousands of miles? Certainly, no man's voice could be *that* powerful! The fourth dimension is most assuredly possible; several of the world's foremost mathematicians have declared it a reality.

By far the simplest method of solving four dimensional problems is to reduce them to problems in three, or fewer, dimensions. We may do this because, by definition, the dimensions are homologous, and hence every problem dealing with four dimensions will have a three dimensional analogue. (The relationship is the same as that between plane and solid geometry.) Having once solved the problem for three dimensions, we may usually "step up" the solution to four dimensions.

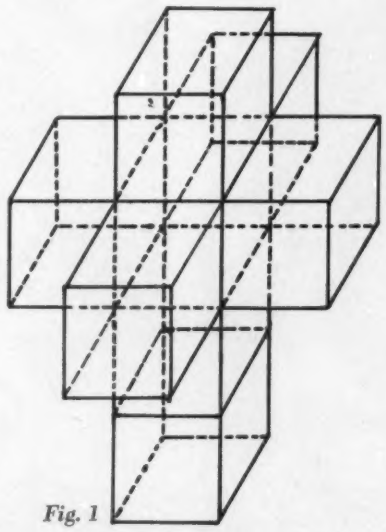


Fig. 1

The fourth dimensional "cube," developed (unfolded) so that it can be seen in three dimensions.

We shall deal first with the simplest of all four dimensional figures, the four dimensional cube. [Strictly speaking, a four dimensional cube is not a cube, any more than an ordinary cube is a square. It is rather the four dimensional analogue of a cube. Some writers denote it by the term "*tesseract*" or hypercube. In this paper, however, we shall understand by four dimensional cubes, spheres, etc., the four dimensional analogues of the three dimensional figures.] This figure bears the same relation to the familiar three dimensional cube that the three dimensional cube bears to the square (two dimensional). Continuing still further down the scale, we come to the one dimensional analogue of the square (or cube), namely, a straight line of definite length. If this line is reduced one more dimension, it will become a point, which has no dimensions. It is quite easy to see that these figures are related to each other by a definite law: A point (A, see Figure 2), when moved a certain definite distance in a direction at right angles to itself (*i.e.*, in the direction of the next higher dimension), will generate a straight line (AB); this straight line, when moved the same distance in a direction at right angles to itself, will generate a square (ABCD); this square, when again moved the same distance in a direction at right angles to itself, will generate a cube (ABCDEFGH). Now, if this cube be moved the same distance in a direction at right angles to itself (*i.e.*, at right angles to each of its three dimensions), it will generate a four dimensional cube.

It is, of course, impossible to visualize a four dimensional cube, but by noting its properties, we may form a fairly definite mental concept of it. By writing down the properties of the line, square, and cube, we may induce the general properties of a cube of any dimensions (termed an n-dimensional cube) or, in particular, the properties of a four dimensional cube. Referring to Figure 2, let us represent the length of the line AB by the letter l. Then the length of any side of the square or cube will also be l. The total space inclosed in the line is its length (*i.e.*, space $=l$); the space inclosed in the square is its area, which is equal to the square of one of its sides (space $=l^2$); the space inclosed in the cube is its volume, and this is equal to the cube of one of its sides (space $=l^3$). By induction, it is apparent that the space inclosed in a four dimensional cube, *i.e.*, its four dimensional volume, will be equal to the fourth power of one of its sides (space $=l^4$).

Let us now determine how many bounding faces a four dimensional cube has. By "bounding faces," we mean the lines, planes, or the like, which completely inclose and define a geometric figure. A straight line of definite length is completely defined by two points, one at each end of the line. When we consider a square, we see that four lines are necessary to inclose it, and simi-

$$2R,\ \pi R^2,\ \frac{4}{3}\pi R^3,\ \frac{1}{2}\pi^2 R^4 \ldots .$$

larly, a cube requires six square faces. Continuing the numerical series, 2, 4, 6, we should expect a four dimensional cube to have eight bounding faces. This can be proven analytically as follows: As previously explained, any member of the cube series (line, square, cube, etc.) may be generated by moving a member of the series of next lower dimensions in a direction at right angles to itself (see Figure 2). We shall denote the initial and final positions of the generating figure as bases. (In square ABCD, Figure 2, lines AB and CD are the bases.) It is self-evident that every member of the cube series will have two bases. In general, the bases, which constitute only two bounding faces, are not sufficient

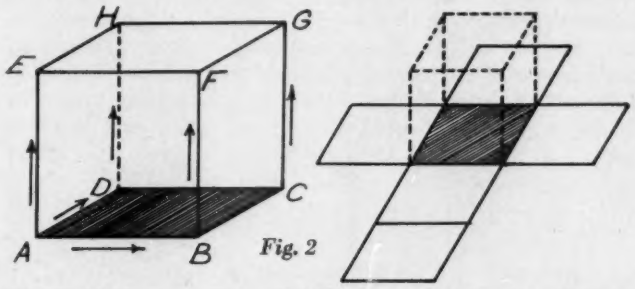


Fig. 2

The development of a solid from a point by translation. At right, a cube developed into a plane by unfolding.

to inclose completely the figure. The remaining faces which are necessary we shall term "lateral faces." In square ABCD, Figure 2, lines AD and BC are lateral faces. The lateral face AD is itself generated by the motion of point A, and the lateral face BC, by the motion of point B. But the points A and B are the bounding faces of the base of the square, and hence the number of lateral faces of the square must be equal to the number of bounding faces of its base (in this case, two). Similarly, the cube ABCDEFGH has four lateral faces (the squares ABFE, BCGF, CDHG, and DAEH), each one generated by the motion of one of the bounding faces of the base of the cube, and as before, the number of the cube's lateral faces must be equal to the number of bounding faces of its base, or four. As shown before, every member of the cube series will have two bases besides its lateral faces; hence a cube will have four plus two, or six, bounding faces — a fact which agrees with our knowledge of the cube. Considering now the four dimensional cube (which is, by definition, formed by moving a cube at right angles to itself), we know that the number of its lateral faces will be equal to the number of bounding faces of its base. But its base is a three dimensional cube and has six bounding faces; therefore the four dimensional cube will have six lateral faces, or a total of eight bounding faces (six lateral faces and two bases). We shall not bother to prove conclusively that these faces are congruent cubes (three dimensional), but this is quite evident from the fact that the bounding faces of a cube are congruent squares, the bounding faces of a square, congruent lines, and the bounding faces of a line, congruent points.

It is interesting to note that a four dimensional cube may be made quite concrete by the simple geometric process known as development, or unfolding. By means of this process all rectilinear figures, having any number of dimensions whatsoever, may be reduced to figures of one less dimension. A cube (three dimensional) may be unfolded to produce the plane figure (two dimensional) shown in Figure 2. The figure shows the development and the cube (shown in dotted lines) from which it is derived. If we examine the construction of the development, we see that it contains a center square (shown shaded in both diagrams), which is the base of the original cube. On each side of this square is constructed another square, and an extra square (the top of the cube) is then added to any of the four arms of the cross. We may follow the same method of construction to produce a development of a four dimensional cube: Taking a base of the four dimensional cube (which is, of course, a three dimensional cube), we construct another cube on each of its sides, and then add an extra cube. The resulting cross-like figure is shown in Figure 1. If we add up the number of cubes in this figure, we find that it totals eight, which agrees with the number of bounding faces of a four dimensional cube.

We come now to the subject of four dimensional spheres. Let us study first the laws of formation of the sphere series. A one dimensional sphere consists of two points (A and B, Figure 3). Point O, the midpoint of a line joining the two points, is the center and also the axis of the one dimensional sphere; the distance OA is its radius. If the one dimensional sphere be rotated around its axis (the point O), a two dimensional sphere (*i.e.*, a circle) will be generated (see Figure 3). In order to generate a three dimensional sphere, the circle must again be rotated about an axis. We cannot use the point O as an axis, however, for if we do, it will permit the circle to spin around its center like a wheel, still remaining in its original plane. By choosing any line through the circle's center (*e.g.*, the diameter AB of the circle ACBD, Figure 3), we prevent the circle from rotating in a plane; the only way it can possibly rotate is in the direction of the third dimension (shown by arrows in Figure 3). When it rotates in this manner, a sphere is produced.

Let us now see how a four dimensional sphere can be generated by the rotation of a three dimensional sphere. We have used a point and a line as successive axes of rotation; we must now use a plane as an axis. [An axis, in the accepted meaning of the word, cannot be a plane, but we shall use this word for want of a better term.] Indeed, a line as an axis would be insuf-

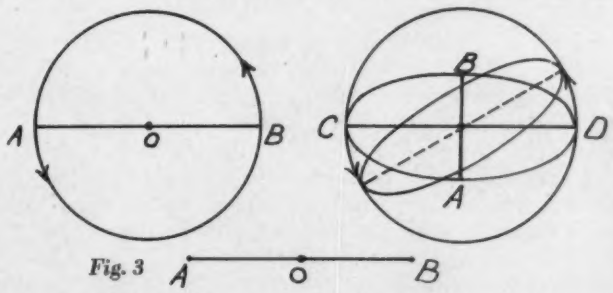


Fig. 3

The evolution of the sphere, from point to solid, by translation and rotation. Revolving a sphere about a plane will produce a "sphere" of four dimensions.

ficient, insomuch as it would permit the sphere to spin on its axis just as the earth does; a plane axis will cause the sphere to remain fixed in three dimensions, leaving only the alternative of rotating through the fourth dimension (cf. next to last sentence in preceding paragraph). This plane axis, like the point and line axes, must pass through the center of the sphere. In Figure 3, the sphere, when rotated about the center plane ACBDO, will generate a four dimensional sphere.

If we attempt to derive a formula for the space inclosed in a four dimensional sphere (*i.e.*, its four dimensional volume), we see that the process is not

(*Continued on page 20*)

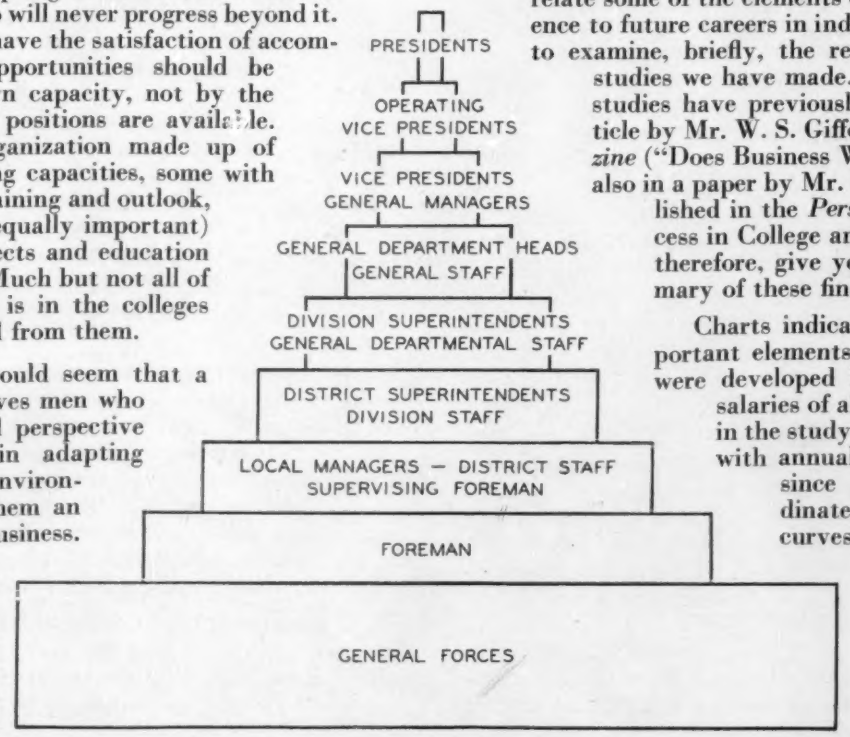
ENGINEERING EDUCATION—ITS RELATION TO A SUCCESSFUL CAREER

By R. I. REES
The American Telegraph and Telephone Company

THE engineering student finds himself confronted with an educational system which presents so wide a variety of activity that he is forced to limit his participation in them. Besides his technical training, participation in so-called extra-curricular activities is urged upon him. Courses in cultural subjects, and the study of economics are offered. The student must ask himself, "What, after all, is most important for me to know? What is the most valuable part of my college experience?" The experience of large commercial organizations has thrown much light upon this problem. Success in large corporations has been studied, statistically. The engineering student who is interested in knowing how best to succeed in such an organization can find valuable information in these statistical surveys.

In order that he may start with the right background, it is important to recognize that almost all business organizations build up in the form of a pyramid. At its base is the large majority of rank and file employees; next, there are the foremen; one step higher, district and division heads, and the departmental staff; over them, department heads, general staff, general managers, vice-presidents, and finally, the president. This form of organization is indicated schematically in the illustration below. The number of positions at each level in this pyramid is substantially less than the number in the next lower level. Ideally, of course, each man should progress from the general forces up through successive levels, to a position of real importance, but both human limitations and the small number of more important positions inevitably prevent this. At every level, not excepting the lowest, there will be numbers of men who will never progress beyond it. If these men are to have the satisfaction of accomplishment, their opportunities should be limited by their own capacity, not by the fact that no better positions are available. This means an organization made up of employees of varying capacities, some with distinctly limited training and outlook, others (and this is equally important) with the best intellects and education that one can find. Much but not all of this latter material is in the colleges and must be secured from them.

In general, it would seem that a college education gives men who complete it a broad perspective and a flexibility in adapting themselves to their environment, which give them an excellent start in business. In the long run they should obtain more than the normal share of important places, and in the early steps of their careers will undoubtedly make more rapid progress than many men of less formal education. As time goes on, however, they will find many men in this latter classification competing very actively with them for these places, and developing just about as rapidly. Both because of the value of their education, and because they probably were originally a more selected group, college men will have some decided advantages over other men in business, but they must recognize and respect the great ability of some of these men, and if they wish to reach the top positions, they must continue to grow and develop themselves steadily over a long period of time.



Naturally, men with engineering education will fill positions which demand the engineering background which they possess. However, in the broad phases of business, engineers need to realize that in business as well as in life there are many problems in which an engineering method of attack may be appropriate, but to which no engineering solution can be found. In these fields the attitude of employer, customer, or the public, may be far more important than the bare quantitative elements of a problem. The engineering student, therefore, if he wishes to progress beyond technical responsibility, should gain some knowledge of psychology. He must certainly recognize the economic, as well as the physical aspects of a technical problem. He must be able to state and interpret his conclusions in writing and in speech so that they will carry conviction without creating antagonism. Real attention should be paid to those required or elective subjects which lie outside the strictly technical curriculum.

Giving our attention now to an attempt to relate some of the elements of your college experience to future careers in industry, it is interesting to examine, briefly, the results of some of the studies we have made. The results of these studies have previously appeared in an article by Mr. W. S. Gifford in *Harper's Magazine* ("Does Business Want Scholars?"), and also in a paper by Mr. D. S. Bridgman, published in the *Personnel Journal*, "Success in College and Business." I shall, therefore, give you only a quick summary of these findings.

Charts indicative of the most important elements in college education were developed by first plotting the salaries of all of the men included in the study on a scatter diagram, with annual salary and earnings since graduation as co-ordinates. Salary progress curves, dividing the whole into three groups equally, were then constructed. Similar scatter diagrams for the group selected on the basis

(*Continued on page 18*)

STRIP COAL MINING

By JOHN A. GARCIA
Mining Engineer, Chicago

MINING coal by the strip method means, essentially, exposing the seam to daylight by removing the overburden or cover and loading the coal directly into cars for shipment. In America, practically all the work of moving the earth, rock and shale above the coal is done by means of power shovels, either steam or electrically driven, but abroad, especially in Germany, continuous bucket excavators with conveyor bridges are standard equipment. The coal is also loaded mechanically by shovel, but of much smaller capacity than the stripper.

When strip coal mining was started in the United States, about 1866, the operations were conducted with scrapers, slips and animal power, and it was not until the late seventies that the first steam shovel was used. The development of the mechanical units was necessarily slow because of the expense involved in the design and adaptation to the increasing difficulties due to rock, mud, thick overburden and high ratios. However, after 1911, when the first revolving shovel was introduced into coal stripping fields of Illinois, and the extensive use of steam shovels on the Panama Canal gave impetus to the movement, quite rapid progress was made by the manufacturers in the design and development of the full revolving shovel. In fact, improvements in the art came so rapidly after 1915 that obsolescence became a major factor in the cost of producing strip coal.

The construction of a thoroughly modern coal strip operation now requires the very best engineering talent from the prospecting stage and layout of the cuts on through the mechanical, electrical, civil, and almost every other branch of engineering. In the operation of a strip pit, the schedule must be so arranged that each unit will synchronize with the other, to the end that continuous operation may be had, especially during the coal loading period of eight hours. The big shovel and drag line often work sixteen and, in many cases, twenty-four hours a day, while coal loading (under union rules) may be carried on only for eight hours.

The thickness and character of the overburden is determined by drill holes, and thorough prospecting is of vital importance to the successful operation of the pit. Many failures may be attributed to the false economy of "saving" money during the preliminary drilling period before purchase of equipment. The surface contours, location of ravines, cropline, thickness of rock and its hardness, are all important factors in the scheme of things, not only to determine the location and extent of the opening or "box" cut, but the whole future line of attack in the pit operation. In addition to drill holes, test pits or shafts should be sunk at reasonable intervals to secure fair samples of the coal from which accurate data may be obtained as to its physical and chemical characteristics.

In the operation of a coal strip pit, one of the largest factors towards success is to maintain enough exposed seam so that the coal loading shovel may operate continuously and not be subject to delays due to mechanical disability of the stripping unit, or improper adjustment of capacities. The strip unit must uncover the seam at a rate that will not only provide ample supply for the coal shovel, but it must synchronize with the latter so that spoil area is always available. The excavated overburden is deposited in the depleted coal sections, and continuity of operation necessarily requires proper adjustment of capacities in equipment for removing overburden and the machine used to load out coal.

Again, the haulage facilities must be co-ordinated with the capacity of the coal shovel so that empty cars are always available for loading during the eight-hour period of coal production, and this requires periodic shifting of the storage stubs or sidings as the face advances and skillful management of train or car movement. The tipple loading and dumping section of the operation must be designed for peak rather than average loads because there must be no delay to the haulage as the loaded trips must be dumped as rapidly as possible and returned to the pit. Feeders, conveyors, screens and loading equipment are, therefore, designed on basis of dumping capacity rather than daily or hourly production.

The question of freight rates to market is also one of prime importance in strip mining as in all commercial activities, since cost of haulage to market is usually more than cost of production in both shaft and strip coal operations. A badly managed strip plant with a low freight rate to a ready market may be profitable, whereas the best kind of a strip pit with ace-high management may fail of success if its available markets are on a "long" rate or saturated with competitive fuels. Therefore, three major considerations confront the consultant in his study of a coal strip proposition — the physical which is purely engineering, the operation which is a combination of engineering skill and managerial ability, and the sales or marketing problem. These three elements are inherent in any industrial problem and are emphasized here only in an effort by the writer to destroy the prevailing belief of the investing public that a "coal strip proposition" is always a sure money making institution; it is not, and in addition to the many problems inherent in this special branch of mining, there is the burden of wildcat "security" salesmen and stock jobbing activities.

(*Continued on page 19*)

Typical strip coal mining, showing the use of modern shovels, whose cost sometimes exceeds $300,000.

WELDING FOR MODERN STRUCTURES

By WILLIAM L. WARNER
Welding Research, Watertown Arsenal

WHEN welding was being advocated for structural work about ten years ago as a new and untried method the idea was looked upon with skepticism. It had interesting possibilities but methods of "procedure control" of the "personal element" and other factors had not been developed and experience was lacking. About the only thing which kept the issue of "whether to weld or not to weld" alive was the enthusiastic optimism of welding advocates who believed in the possibilities of welding. The structural steel industry regarded the arguments proposed with a certain amount of sympathetic tolerance and refrained from active participation in the discussion.

After about five years of discussion the welding industry, represented by the American Welding Society, and the structural steel fabricators, represented by the American Institute of Steel Construction, jointly organized a committee, the Structural Steel Welding Committee of the American Bureau of Welding, and laid out a program of investigation proposed to obtain data for design of welded steel structures.

Funds for the investigation were contributed jointly in cash, and the services of many experienced individuals were given gratis to carry out the test program successfully.

Five years have been required to complete the work as planned originally and many thousands of dollars in time and brain power have been spent to insure the accuracy and dependability of the results.

There are two fusion welding processes in use today for structural welding, viz., the oxy-acetylene and the electric arc. Of the two the latter is probably the more extensively used for the joining of members, although no structural steel work could be carried on satisfactorily without the gas cutting torch.

Generally speaking there are four fundamental forms of fusion weld, the butt weld, the fillet weld, the edge weld, and the corner weld. Two others which are more or less special are the plug weld and the slot weld. Of these types the fillet weld is used most for structural work, and there are numerous variations of each type, all having their individual designation in the standard nomenclature of the American Welding Society.

The design of a welded structure is based upon an average unit strength of the weld depending upon the form of the weld and the type of material used. Such unit strengths must be determined by experiment and are for bare low carbon steel electrodes.

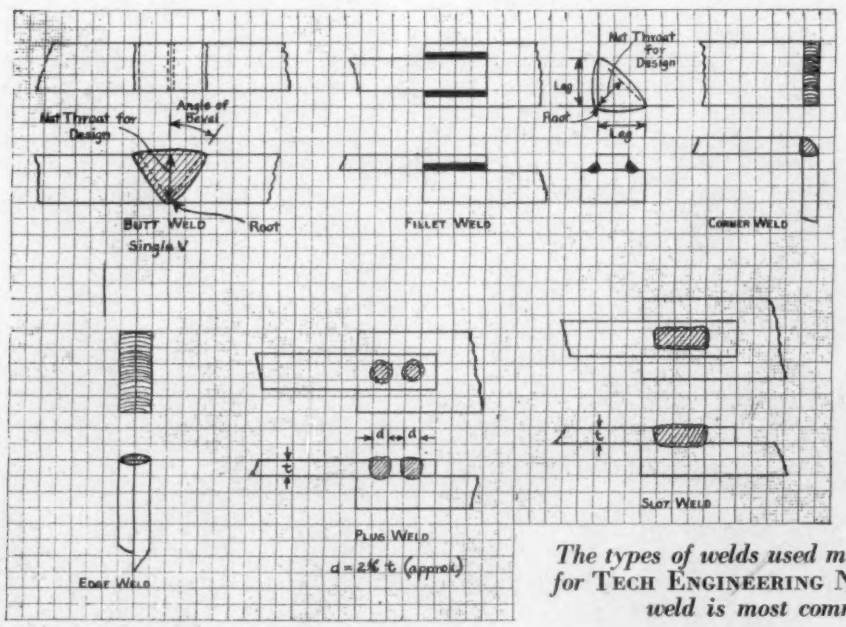
There is proposed the use of a fillet weld test specimen by which may be obtained the strength of fillet weld produced by the welder. The average ultimate strength of a $\frac{3}{8}$-inch fillet has been determined by numerous tests to be 12,000 pounds per linear inch of fillet. This figure would require the welder to produce a specimen showing a total load of not less than 72,000 pounds. For the complete test the inspector may specify that the welder make two of these specimens in each of several positions, depending on the type of work the welder is to do. The inspector must check the size of the welds to make certain they are not oversize, and by watching the specimen being made he can judge whether the welder has had any experience with fillet welds. Generally a welded structure is designed so that no overhead welds are necessary.

There is not sufficient opportunity in the present discussion to cover the subject of test results of structural welds. As a result of the tests the Structural Steel Welding Committee recommends the use of the unit working stresses for shear, tension, and compression as already noted, "provided the welder has been qualified and provision has been made for bending stresses that may be introduced due to eccentricity," and concludes that "In commercial practice a welded joint may be expected to have a strength within twelve per cent of a general average for that type of joint, provided the welder has attained the stated qualifications."

A structural welding code has been prepared by the American Welding Society which has been adopted either wholly or in part by a number of municipalities and many others are considering its adoption. A number of multi-storied buildings or additions to existing structures have been built by this method during the past five years. While this article is being written there is under construction by welding an addition to a large hospital in Boston. The advantage of its quietness is quite important for such work.

It is quite evident that there is a growing confidence in this form of building construction, and the student engineer should give the subject some study. Little can be said of the application of welding to bridge construc-

(*Continued on page 16*)



The types of welds used most commonly by up-to-date operators, drawn for TECH ENGINEERING NEWS *by the author. Of the six shown, fillet weld is most commonly used for structural purposes.*

ENGINEERING DIGEST

Condensations of outstanding articles in the leading trade and scientific journals, published by special permission.

New York's New Subway Cars

Condensed from Scientific American, *January 1932*

New York has the very latest in subway cars. These cars, costing $38,000 each, have been built for use in the new Eighth Avenue subway and it is interesting to note their construction. The contract specified that delivery must begin within six months of the contract award and continue at the rate of 40 cars per month. Extensive plans were laid by the American Car and Foundry Company, of Berwick, Pennsylvania, where the cars were built. Over 600 drawings were required, in addition to 300 more which were furnished by makers of accessories. One drawing, showing everything under the floor, was 12 feet long and cost as much as a good automobile.

These new cars have many devices never before used. The underframe for the most part is made of carbon manganese steel, stronger and lighter in weight than ordinary steel. The cars were to weigh not more than 85,000 pounds, and when weighed the sample car was found to be 600 pounds under the allowable limit. These cars, 60 feet 6 inches long, will comfortably accommodate sixty passengers, and can be made to accommodate 280. Four doors on each side of the car, all controlled from one point, make possible fast loading and unloading of passengers.

Over a freight car load of material came into the plant for each car built. There are more than 1,600 different designs of pressings, forgings, and flat items, or 6,000 individual items. For each car 12,300 screws, 22,558 rivets, 1,200 bolts, 5,000 nuts, 737 pieces of conduit, 451 pieces of air pipe, and 43 miles of wire were used. Over 100,000 holes were punched in making a single car.

Bumping the cars together not only locks them together but also couples the air brakes and 30 electric circuits, and the turn of a handle breaks them all simultaneously. These cars were brought from Berwick to New York on their own wheels and the motors were installed there.

Up Hill, Down Dale

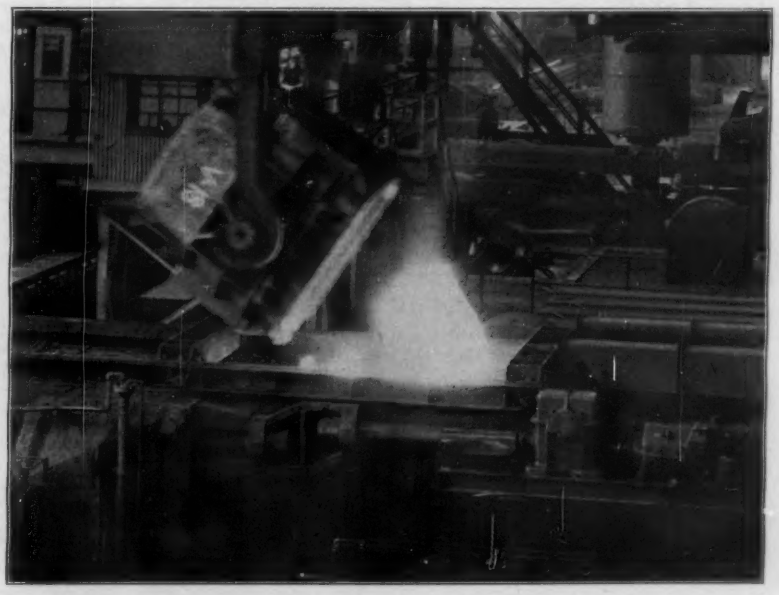
Condensed from Western Electric News, *January, 1932*

Sound recording is today advancing from a winding ravine into a straight canyon with a roller coaster at the bottom. This, in a word, describes the result of recent developments in the technique of making vitaphone and phonograph records.

For many years the accepted method of cutting grooves in records has been the "lateral cut" system. A stylus or cutting point digs a miniature ditch in the surface of the blank record as the latter is made to rotate. The recording mechanism is so arranged that sound impulses are translated into lateral movements of the stylus; consequently the resulting groove, when viewed under a magnifying glass, looks like a trench dug by a ditch digger who has literally "gone on a bender." This is made plain in one of the illustrations.

The system which now bids fair to supplant the lateral cut method is called the "hill and dale," or vertical cut, system. The stylus in this case moves up and down, so that the resulting groove is perfectly straight (or rather a perfect spiral about the center of the record), but of variable depth. "Hill and dale" recording is an improvement in several respects. The most obvious of these is that the grooves can be cut about twice as close together as before, doubling the playing time of the record. More important, though, is the improved quality of reproduction. With a lateral cut record the needle must be of just the same width as the groove. Consequently a little abrasive material is included in the composition of which records are made, to grind the needle down to the correct width. Naturally, a grindstone in the background detracts from the quality of the finest of music.

With "hill and dale" records, on the other hand, it is not essential that the needle fit snugly in the groove; accordingly, the needle is made of sapphire and the record of wax. The old scratchiness, which was a frequency sound, has been removed, and its elimination has been largely responsible for the extension of the frequency range to new limits. Where the phonograph of 1924 had a range of from 350 to 3,500 cycles per second, and today's talkies run from 70 to 5,000 cycles, the new method has already yielded a range of from 30 to 9,000 cycles per second. The value of this achievement lies in the fact that overtones, which determine the quality of a musical note, are now much more completely reproduced than they have been in the past. Increased volume is also made possible by the new system, for the maximum difference in height between the miniature hills and valleys can be much larger than the greatest possible deviation in the groove of a lateral cut record. That is, a phonograph needle can have a larger amplitude of vibration with the new type of record



Six thousand pounds of wrought iron, poured into a press which compresses it, preparatory to rolling into beams.

Tracks on the surface of a phonograph record (greatly enlarged) produced by the so-called "lateral process." The needle is displaced laterally as it follows the track.

Western Electric Review

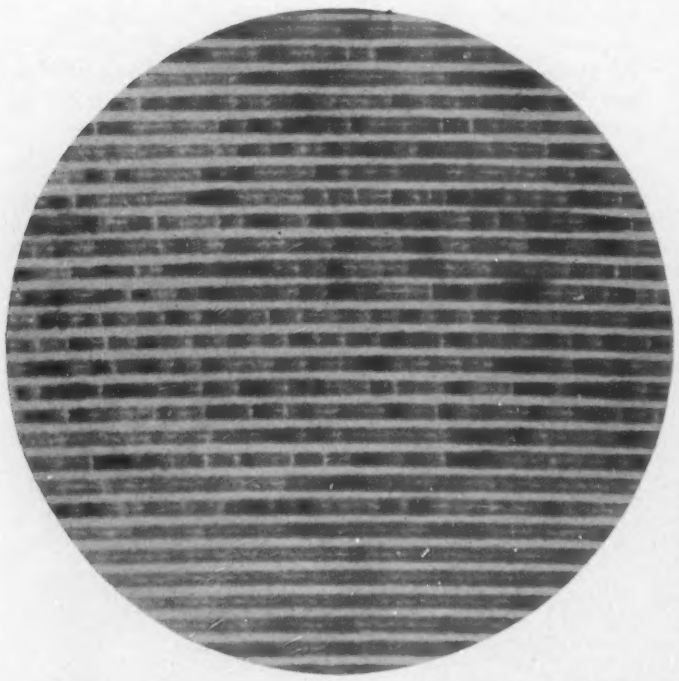
than with the old. And finally, the vertical cut records may be played hundreds of thousands of times without appreciable loss in quality!

Further development of the "hill and dale" technique is being carried on, and it is confidently expected that the entire audible spectrum, from 16 to 13,000 cycles per second, may in the near future be capable of reproduction.

Will the Atom Surrender?

A new assault on the most strongly fortified citadel in the world is soon to be made by Dr. R. J. Van de Graaff of Princeton University, who is at present at M. I. T., working on a novel apparatus for generating high-voltage electricity. This fortress — one that we are destined never to see — lies within the atom and constitutes its nucleus. Its disruption, if accomplished, will be the greatest experiment in the memory of human beings.

To understand Dr. Van de Graaff's apparatus and the reason for utilizing the great battering ram of high voltage we must understand what an atom is. At this late day everyone knows that an atom is a complex structure of electrons and protons. At the center lies the almost impregnable nucleus, composed of negative electrons and positive protons, which latter are also the nuclei of hydrogen atoms and the primal components out of which the universe is built. Surrounding the nucleus are planetary electrons that vary in number with the weight of the atom. Hydrogen has one planetary electron and at the other end of the list is Uranium with multitudinous electrons. Although matter seems to be very dense, it is porous and empty. Protons and electrons are infinitesimal; if an atom were as large as a mountain its electrons would be no larger than eggs and its protons in the nucleus would be about as big as pin heads. A proton is much smaller than an electron, yet the mass of an atom lies all in the protons making up its nucleus. It is the nucleus that gives an atom most of its properties. Out of the nucleus also come the alpha, beta, and gamma rays of radium and other self-transmuting elements. Electrons are small bits of electricity. Hence the forces that protect the nucleus from disruption are electrical. Around the nucleus is a high voltage wall. Projectiles fired against the nucleus must penetrate that barricade. The atom is so small that a speck of dust, invisible to the naked eye, contains a thousand million millions of atoms. Yet to reach the nucleus requires energy measured by millions of volts. It is impossible to hit the nucleus of a single atom by employing a single projectile; a blunderbuss of enormous power must be used. Countless projectiles must be cast against billions of atoms in hopes that a few may hit the nuclear mark. The alpha particles of radium have been found to be the most practical for use as projectiles. They are nothing but the nuclei of helium, small but relatively heavy aggregations of protons and electrons. Incidentally they have a speed of 12,000 miles per second.



Western Electric Review

Previous attempts have been made to disrupt the atom, but no experiment has thus far been successful in penetrating the nucleus itself. Usually the wall would deflect the alpha particles by electrostatic repulsion. The lighter elements have been attacked with some success, hydrogen having been knocked from nitrogen, boron, fluorine, aluminum, and phosphorus. Bombardment with alpha particles has only frayed the atomic nucleus, yet this success has been of tremendous consequence to science. The crashing of a particle into a nucleus has been photographed and observed with the microscope. Protons or alpha particles splashed against a fluorescent screen and momentarily spurted light. Since little more was to be gleaned from alpha particle bombardment, physi-

The "up-hill down-dale" method of recording, a new development, allows the needle to follow the sound track with a minimum of scratching, and with increased fidelity of reproduction.

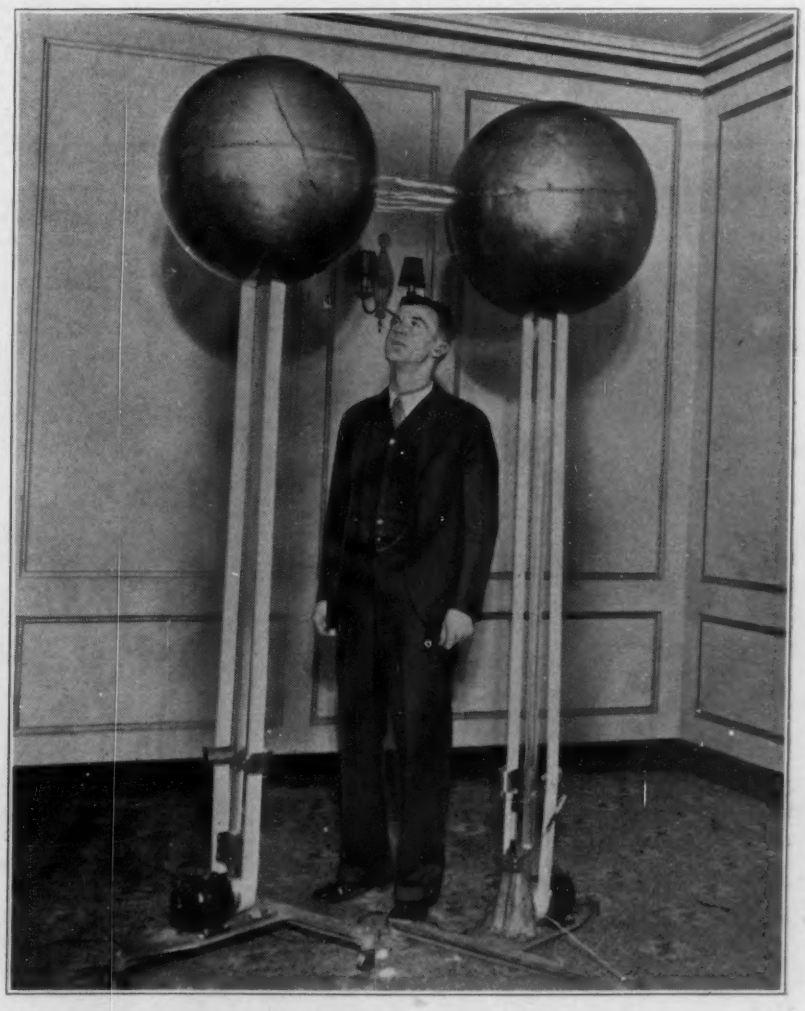
cists saw that it was necessary to build new and more powerful weapons. When they speak of 10,000,000 volts scientists have an electrical drop in mind. Between the positive and negative terminals of a spark-coil or an X-ray tube there is a potential drop. If 500,000 volts of positive electricity are applied to the one terminal and 500,000 of negative to the other, the drop is 1,000,000 volts. If an alpha particle is dropped over this resulting gap it will damage and possibly destroy whatever it encounters. An electrical gun will be pointed at matter when Dr. Van de Graaff's apparatus is trained on the atom.

The usual way of obtaining high voltage or creating a large drop is to generate a current at relatively low voltage and then to step it up by means of a transformer. What distinguishes Dr. Van de Graaff's apparatus is the simple way in which a steady high voltage is generated and maintained. He has returned to the principles that were applied when electricity was newly discovered, the principles of static electricity. It has long been known that the best way to get rid of a static charge is to discharge by way of a point and the best way to hold it is on a metal sphere. Moreover, the electricity collects all on the outer surface of the sphere. Here we have the principle that Dr. Van de Graaff applies in his apparatus. Static electricity is generated and transferred to spheres. If a high voltage is desired, it may be obtained by enlarging the spheres; it is thus possible to generate practically any voltage. To generate the electricity endless silk belts which pass over pulleys are utilized. One pulley is mounted at the base of the pedestal that supports the sphere and the other within the sphere itself. The electricity is produced by rubbing the silk in the old-fashioned way. Thus the belt is charged and travels into the sphere, little points of metal transferring the charge to the surface; one sphere is positively charged while the other is negatively charged. The belts of the two spheres travel in opposite directions so that one belt is a charger of positive electricity and the other a discharger of negative electricity.

Every electrical spark is composed of free electrons — negative electrons of the very kind that enter into the construction of an atom. If these electrons be allowed to stream through an exhausted tube containing a metal target, they will set the atoms of the target into such violent agitation that they will emit radiation. It is possible that Dr. Van de Graaff, by using such an X-ray tube with his new generator, may even approach the soft cosmic rays in penetrating power and thus shed light on their origin. In any case, neither he nor his assistants will sit within the spheres when such dangerous radiation is produced. The physicists will have their colossal apparatus hauled on tracks into an airship hangar and will take up their positions behind blocks of steel and concrete while the electrical storm rages and X-rays of tremendous power shoot out from the target.

Several thousand times as much radium as there is now in the laboratories of the world would not equal that tremendous outpouring of penetrating radiation. It is inevitable that amazing results will be observed. The eyes of the scientific world are focussed on this attempt at the seemingly impossible task the successful culmination of which has been the ambition of scientists ever since the dark ages.

BUILT TO HOUSE a staff of seven hundred highly trained research engineers, an unusual laboratory has recently been placed in service. The exterior is of stone, aluminum, and glass, while a generous use of metal inside is in keeping with a business based upon the metal industry. The entrance and lobby are in black, dark blue-green, green satin finish, and polished aluminum. Gray, blueprint blue, and black constitute the general color scheme of the upper floors. Metal equipment for office and laboratory is finished in soft green, aluminum, and blueprint blue. All interior columns have been omitted in order to make large floor areas possible, while removable partitions of special design permit extreme flexibility. A large two-story craneway, roofed over with skylights, is equipped with removable slabs to permit the installation of especially tall experimental equipment. A V-shape bay type window is used to give the maximum amount of natural light, while air conditioning provides the most favorable working conditions.



Dr. R. J. Van de Graaff, of the Physics Department, with his newly developed high voltage generator. A larger machine, in the process of construction, is expected to produce a potential of many millions of volts.

The TECH ENGINEERING NEWS

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EDITORIALS

T. E. N.— As *You* Like It

This issue of T. E. N., the first to be presented by the present Managing Board, is offered in a spirit of inquiry. The experience gained in the preceding volume indicates that our readers are interested more in articles of a general engineering and scientific nature than those specialized technical discussions which have been published from time to time in these pages. On the other hand, certain of our readers have commended us when some highly technical subject has been treated by an authority. Though it is true, in general, that no editor ever pleases more than 51 per cent of his readers at any one time, it is, of course, our sincere wish to maintain a much higher percentage of "satisfied customers."

For this reason, a particular effort will be made, by the fifty-odd members of the Managing Board and Staff of T. E. N., to secure from friends and acquaintances sincere opinions on the articles presented in this issue, and upon the quality of T. E. N. in general. From this "mass of data," a definite editorial policy will be formulated, and, we hope, adhered to throughout the duration of the volume.

Those readers who feel inclined to direct their opinions first-hand, are invited to communicate with any member of the Managing Board, either by mail, or at the offices in Walker Memorial.

The result of the survey will be published in this column next month. Though a published avowal of policy is often dangerous, we believe that our subscribers are entitled to know what they may expect.

For the present, suffice it to say that reader interest is the standard by which all manuscript will be judged. Our immediate concern is to define, exactly, the interest of our readers.

Are Engineers People?

In the engineering literature of the day, there is a widespread tendency to forget that engineers are not only well trained manipulators of natural laws and resources, but human beings as well. They are adjudged fit to construct bridges and operate public utilities upon which thousands of people depend, but in any discussion of the human qualities, the engineer's opinion is too often ruled out. Some say this is true because an engineer has so many technicalities to master that his outlook upon life in general is foreshortened. It is our wish to take issue with this point of view.

The general level of intelligence required for the successful completion of any engineering course offered in the United States today is admittedly high. In most universities, the Engineering Course is looked upon as "tough." Why, then, is not a graduate of such a course entitled to as valid an opinion as that of, say, a politician? The answer is that he *is* just as well qualified, and in the majority of cases far better qualified, to state his opinions as any other person. Whatever shortcomings he may have, the technically trained man is a specialist in common sense.

As an example: the editorial which appears below was submitted by a member of the editorial department rather doubtfully, and it was accepted for publication only after long consideration. Why? Because already, the inferiority complex that engineers habitually display about matters "outside their line" was showing itself in writer and editor. But birth control is a subject

in which every thinking person should be interested. Why should not the engineer, who is particularly trained in logical, practical thinking, be fitted to state and discuss his opinion on a subject of such practical importance? We believe he should be encouraged to do so. Hence the editorial is published. We welcome comment.

The Engineer and Eugenics

The Church and State are today combined in their alarm at the Gargantuan proportions assumed by the Crime Wave. When "Legs" Diamond's fortunate demise is as much publicized and glorified as the death of Thomas Alva Edison, there is need for anxiety, not only in the select circles of Ladies' Aid Societies, but in the minds of the educated classes.

Even the most pessimistic biologist, T. Swann Harding, for instance, will admit that there are low levels of human intelligence, the idiot, the imbecile, and the moron, and that "their elimination from the breeding human stock seems advisable as a step in improving average human intelligence."

The engineer and the scientist are supposed to be members of the intelligensia of America. In their hands, therefore — in *our* hands, as future citizens of an enlightened order — lies the power to remedy many of today's most striking social evils.

First of all, let us not be misled by the false enthusiasm of those who expect to create a race of supermen by eugenics. Sir Arthur Keith, the great anatomist, said, "Call it by what name you will. The eugenist must have a stud-farm where he can secure control, isolation, and purity of blood . . . assuming this, it would take at least one hundred generations to breed a race of supermen."

On the other hand, the negative side of eugenics, the science of birth-control, is well worth supporting. It is common knowledge that heredity is one of the greatest aids to crime that exists at present. A system of scientific sterilization would do more, probably, for society than all the reformatories now in existence. Not only that, but the prejudice, born of ignorance and fostered by religion, against birth-control and the use of contraceptives, should be fought with an undying hatred by a very intelligent man.

It is our duty, particularly since we have been privileged to enjoy excellent educational opportunities, to participate with heart and soul in the amelioration of the human race. Let us, the engineers of the future, plan our sincere support of scientific eugenics as applied to social problems.

The creation of the universe in which we live and the origin of life of which we form a part is one of the most interesting and fascinating subjects which can be discussed. It was with that point of view that THE TECH ENGINEERING NEWS asked Professor Frederick K. Morris of the Geology Department to write for us on the origin of life. We are pleased to present his article in a forthcoming issue.

The Managing Board regrets to announce the resignation of Charles E. Fulkerson '33 from the position of Publication Manager of Volume XIII.

BOOK REVIEWS

MECHANICAL LABORATORY METHODS

By J. C. SMALLWOOD
Johns Hopkins University
And F. W. KEATOR
Yale University

D. Van Nostrand Co. Inc., 1931. 386 pp. plus XII.

A thorough revision and extension of this standard work upon Mechanical Laboratory Methods has recently been completed by the authors. The book is a most excellent treatise upon laboratory methods connected with the use of steam, water and power distribution. A few physical laboratory methods regarding accuracy and significant figures are included at the beginning of the treatise. After this, the simpler methods of measuring forces and pressures are taken up. The book does not deal with fundamental proofs or abstract applications, but is confined in a wholesome and desirable manner to laboratory practice in the lines of power measurement and machine performance. The text does not go at great length into laboratory practice in testing materials, nor does it touch upon textile practice. It is, however, replete with information regarding power plant tests and allied subjects. The subject-matter is presented in a clear, concise and straightforward manner, and the cuts, to the number of some one hundred and twenty-five, are readable and informing. At the end are various tables, which would have considerable value in the calculation of test reports. As a summary, there are appended one hundred and sixty typical laboratory problems, the answers to which are given. It would be difficult to find a more comprehensive and direct presentation of the subject than is contained in this treatise.

— G. B. HAVEN.

FINANCIAL ORGANIZATION AND MANAGEMENT

By CHARLES W. GERSTENBERG, Ph.B., J.D.
Prentice-Hall, Inc., New York. 723 pp.

To the student of economic problems this book represents a logical, concise, clear and accurate description of the methods of handling the various problems arising in a new enterprise. Chapters are devoted to the successive steps of promotion, from the conception of the enterprise, through its investigation, organization, and financing, until it becomes a going concern with managerial problems. The entire enterprise is considered from a threefold point of view, in its legal aspects, financial set-up, and managerial problems, with the additional feature that the various alternative solutions to these problems are illustrated with concrete examples from existing corporations. A major portion of the book is given over to detailed consideration of capitaliza tion methods with a thorough discussion of the various expenses connected with each, both initially, and from the standpoint of future operations.

One of the more striking features of this book, not always found in texts on corporate finance, and which may at this time be particularly valuable, is an intelligent and thorough consideration of the problems and various methods of removing a bankrupt or insolvent business from receivership, and reorganizing and refinancing it on a sound basis.

Although some of the more theoretical and historical aspects of the development of corporate organization are omitted, this omission serves to make the book more readable, and keep it within reasonable limits of size.

Together with the value of this book to students of business, it also represents an authoritative reference book to the average reader who is at all interested in finance.

— C. E. B.

WELDING

(*Continued from page 10*)

tion although numerous instances have been recorded where welding has been used in repairing or altering existing structures. Probably this is due to lack of information as to weld performance under impact and fatigue. There is need for investigation along these lines.

At Watertown Arsenal we are concerned with the design and manufacture of Ordnance material which is subjected to vibratory and impact stresses. Fundamentally there are two methods of designing a welded structure. Either the design may be such that the welds carry the stresses between the various parts joined or the welds are employed to hold the parts together mechanically, the stresses being carried from part to part, partly through mechanical interlocking, fitting or because of the position in which they are placed. There are advantages in both methods and both methods are used in Ordnance construction.

The welding of nickel steel presents a problem of porosity which is not encountered to the same extent in welding carbon steel. The amount of porosity is apparently determined by the temperature gradient between the weld metal and the plate, which probably controls the absorption of nickel into the weld. If the arc energy used is below a certain amount, depending on the plate thickness, size of weld, and diameter of electrode, lack of fusion will result, but the weld metal will be sound. The use of an arc energy above a certain amount results in excessively coarse porosity. Between these two limits, which is a relatively narrow range, the weld is satisfactory. These limits for carbon steel are considerably farther apart.

All production welding at the Arsenal is checked by x-ray examination of the welds of each part which are most highly stressed, and each part is identified by a welder's marking in the welding shop which insures that the responsibility for the welding is placed where it belongs. All of the welds are subject to x-ray examination at the discretion of the laboratory and a thorough visual inspection is made. The welding conditions are definitely set for this class of work and any variation from these prescribed conditions is noted on the x-ray films. Bare low carbon welding electrode is used, and the results from the porosity standpoint are generally within about five per cent of a general average which has been established from experience. No other form of check test is made although welding tests are made from time to time to try out new materials and develop the proper welding technique. All welds which are to be physically tested in the laboratory are x-rayed before machining and the test sections recorded on the films, so that the physical results may be correlated with the x-ray results.

Generally the weld is classified from the x-ray film on the basis of six fundamental characteristics as follows: weld penetration, porosity, fusion, edge effect, cracks, and general appearance. If the weld is uniform the remarks apply to the whole film but, if there is any noticeable non-uniformity, each test section is classified independently. The breaks of the test specimens are classified individually on the basis of five fundamental characteristics as follows: Fracture (type and location), structure (of fractured cross section), porosity, fusion, and general appearance.

In this way it becomes possible to better interpret the x-ray films, knowing the general type of weld metal, *i.e.*, whether carbon steel, nickel steel, chrome vanadium, etc., and in general how the weld has been made. The x-raying of a butt weld presents no difficulty, but the examination of a fillet weld is considerably more complicated.

Various forms of test specimens are used at the Arsenal. Usually both tensile and impact tests are made when studying weld characteristics and the effect of electrode, welding energy, and other details connected with the welding operation. Many tests have been made on butt welds and comparisons of details of the welding operation determined, but for some reason or other there have been practically no comparisons of this type made on fillet welds, in spite of the fact that on structural work the majority of welds are of the fillet type.

The question of size and shape of test specimen has not been definitely settled, and often the answer to the problem depends on the ultimate result desired from the test. Where x-ray analysis of the welds is to be made prior to testing, it is desirable that the welds be so situated with respect to each other that they will not be superimposed on each other on the film. It is with this idea in mind that the specimens for fillet welds have been designed. A special fixture is required for holding the specimens in the testing machine. In a similar manner it is possible to design test specimens for testing fillet welds under parallel or longitudinal stress although the specimens will probably not be as simple in form.

HANDBOOK OF FINANCIAL MATHEMATICS

By Justin H. Moore

Prentice-Hall, Inc., New York. 1216 pp. Index. Price $10.00

This book will prove a valuable addition to the library of every student of finance, inasmuch as it contains a wealth of information in the form of tables and formulae, enabling the reader to approach correctly practically any possible problem in finance, from either the debtor or creditor point of view, and solve it quickly, efficiently and correctly, with little or no practical experience. The book contains a detailed description with numerous formulae of the various types of simple and more complex problems of interest and discounts, with adequate tables of present and future values of types of annuities, which are valuable to the average business man who spends a small portion of his time in investment work.

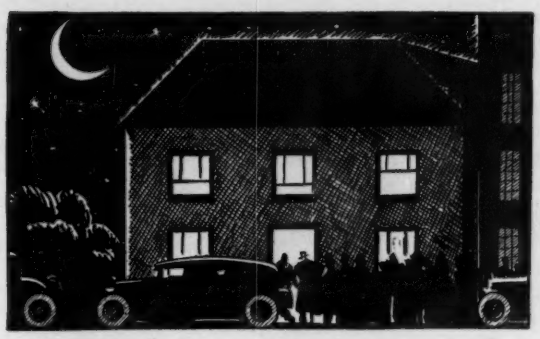
A large section of the book is given over to a discussion of present practices in figuring present prices and future yields of bonds, with a critical examination of these practices as applied to various types of bonds. In this section also are included many of the more elusive bond formulae, and adequate information for solving all problems which may arise in connection with sinking funds and bond amortization, together with some mention of the effect of Federal Income Tax schedules on bond yields.

The various problems arising in finance through depreciation, stock prices, and insurance are fully dealt with by Mr. Moore, together with a detailed discussion of the mathematics of the building and loan association. In connection with the chapters on insurance, a striking feature is the inclusion of the American Experience Table of Mortality, with a detailed treatment of the theories of probability involved in it. Numerous suggestions are made as to other possible uses of the Experience table in solving problems not directly related to insurance.

A very large portion of the book is devoted to a collection of more specifically detailed formulae, together with their derivation, and a valuable group of special tables, including several tables of present and future values of special types of securities.

Inasmuch as this book represents a collection of information which would otherwise have to be gleaned from a large number of smaller separate books, it represents a distinctly advantageous investment for the student or business man, to whom "Time is Money."

— C. E. B.



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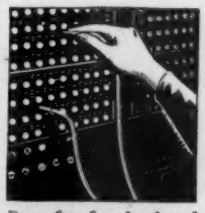

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ENGINEERING EDUCATION

(*Continued from page 8*)

of scholarship, etc., were then made, and it was then determined what proportion of each of them lay in the first salary third of the whole group, what proportion lay in the second third, and what proportion lay in the last third. Comparing this distribution of scholarship with the next one where the men are distributed in accordance with campus achievement, there seems to be some evidence that scholarship is the more significant factor of the two. The distributions for the men with substantial campus achievement, and those who stood in the first third of their classes in scholarship, are practically the same, but the substantial campus achievement men constitute only nineteen per cent, while the first third scholarship men constitute about forty per cent of the whole group. There is some evidence that achievement in editorial, forensic, and managerial activities has been rather more significant than that in social, athletic, or musical and dramatic activities.

The earning of college expenses seems to be of very little significance. At first this seems distinctly surprising, but on further reflection there appears to be cause for it. In the first place, it is recognized that men earn their way through college not because they are able to, but because they have to. Furthermore, although the men with higher earnings were not notably below their fellows in scholarship or in their participation in campus activities, it must be true that such men have sacrificed something in the opportunity for reading, for informal social contacts with their fellows, and perhaps most important, the opportunity for reflection and for gaining a broad perspective on the work they are carrying on in college. On the other hand, the men who have earned their way have shown a degree of determination and capacity for hard work that it has not been necessary for their fellows to demonstrate. There is no question that these men are, in a general way, better off than if they had not gone to college.

Early age at graduation seems to be a small but significantly favorable factor. It is true that the younger men were also somewhat better men in scholarship, but in combining the two factors, more divergence from a normal distribution is obtained than with either factor separately. There seems, therefore, to be some value in early graduation, regardless of scholarship, but it is distinctly small. On the whole, moreover, it seems to be true that a man who finds his field of work first and stays in it, will do better in the long run. It should be emphasized, moreover, that this factor is distinctly independent of all the others.

In summary, these studies seem to indicate that good scholarship, campus achievement, early graduation, in the order named, are significant indices of success. Earnings in college are not significant. On the other hand, it has been found that not all the members of the groups which were highly selected by combinations of these several factors, do succeed. It is very evident that other elements are highly important; what all of these elements are, we have no way of knowing. We *do* feel that many of the failures of men with high scholastic records to make good, have been due to the inability of these men to handle their social relationships properly. To really succeed in business the man must not only make himself acceptable to his fellows, but must be able to win their cordial and hearty co-operation. Other important elements are a man's ability

(*Continued on next page*)

COAL MINING

(*Continued from page 9*)

In 1928, the total strip coal production was only about four per cent of the coal production of the States, but in the Middle West, where the physical conditions in certain areas lend themselves quite readily to the strip system, rather remarkable progress has been made in this branch of the coal producing industry, and in 1931, it is an extremely important branch of the coal business. During the period 1917 to 1929, the production of coal from underground mining remained practically stationary while the strip coal production has steadily increased each year, reaching in excess of 22,000,000 tons in 1929.

It would be interesting to know the total available acreage in the United States that is suitable for stripping, but such figures are difficult if not impossible to obtain, mainly because each year improvement in design of equipment or new inventions make available large areas previously considered as unsuitable. In Il inois alone, the State Geological Survey estimated the reserve coal minable by stripping in 1925 at almost a billion and a half tons, and since that date, new type equipment has been developed that makes available many more millions. In Kansas, the strip fields are quite limited; in Indiana, the reserves are less than Illinois but sufficient for many years of production at peak tonnage. Many millions of tons of sub-bituminous and lignite are available in the Dakotas and Montana, so that, as a whole, the strip coal reserves of the United States may be considered not unlimited but very large.

The cost of producing coal from a modern well managed strip pit is quite low when compared with shaft mining on hand-loading basis, but a completely equipped mechanically loading underground mine occasionally comes close to the stripper when all factors are considered.

It is now possible to estimate with close accuracy the probable production costs and total investment in a strip plant, for data have been accumulated over a sufficient period of time to allow the engineer to forecast the future of a proposition with very little guessing. A careful study of all factors involved, each of which can now be determined, such as overburden by drilling, quality by analysis, labor rates, and equipment costs, lowers to a minimum the financial hazards so inherent in mining, and this fact is probably the main reason for the rapid increase in the development of this branch of the industry.

•—•

ENGINEERS

(*Continued from page 18*)

to adjust himself to the environment of his home and of his business, as distinct from his ability to adjust himself to the environment of college. Another important element seems to be interest in the individual ability to do work which a man has selected for his life work.

It is certainly true that the student who has done well in college, if he is to realize on the capacity and promise thus shown, cannot afford to neglect a careful analysis of himself and a thorough consideration of the businesses where his talents are most likely to be useful. He who has done badly in college has no occasion to believe that his pace has been permanently set; if he has discovered his own motives, his own interests and abilities, if he has gained perspective on the things which may have hindered him in college, he may well choose a field of work from which he can carve out a successful career.

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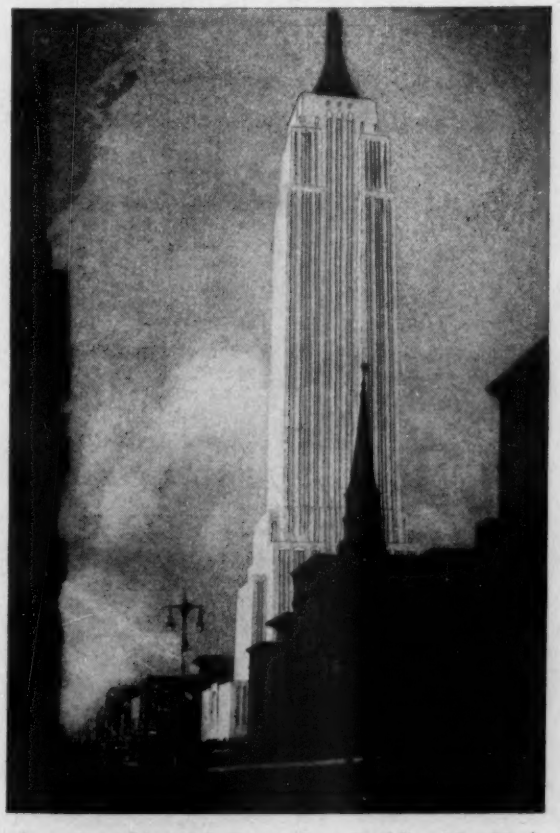

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FOURTH DIMENSION

(*Continued from page 7*)

nearly so simple as it was with a four dimensional cube. Writing down in order the formulae for the space inclosed in a sphere of one, two, and three dimensions, we obtain a series: $2r$, πr^2, $\frac{4}{3}\pi r^3$ (r = radius), but it is difficult to derive the next term of this series by simple induction, since no simple relationship between the terms can be seen. By methods of the integral calculus, however, a formula for the space inclosed in a four dimensional sphere may be obtained: space $= \frac{1}{2}\pi^2 r^4$.

Most people are greatly mystified by Prof. Albert Einstein's theories about a curved space, a closed, and yet unbounded universe, and the like. It is true that the mathematical proofs of these theories are highly abstruse, but the theories themselves are comparatively simple. According to Einstein, the universe may be considered as the surface of a four dimensional cylinder. This means that it is the analogue in four dimensions of a cylindrical surface in three dimensions. It is readily seen that, just as the bounding surface of a circle (*i.e.*, its circumference) is a line — one dimensional — and the bounding surface of a sphere is a surface — two dimensional — so the bounding surface of a four dimensional cylinder will be three dimensional. Since this surface *is* three dimensional, it can contain all the three dimensional objects which make up the universe. The universe, being cylindrical, is naturally curved, but its size is so great that the curvature is imperceptible — just as the curvature of the earth was imperceptible to prehistoric man. Einstein has actually computed the size of the universe; it may be expressed as follows: The universe is so vast, that light, traveling at the rate of 186,000 miles per second, will require five hundred billion years to complete the circuit. Thus we see that the universe is "finite and yet unbounded." It is finite, because it has a perfectly definite circumference and hence a definite volume; it is unbounded because one may go forever and never find an end to the continuity of the surface.

ARGENTINE

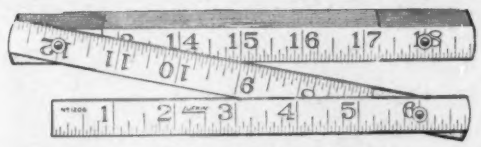
(*Continued from page 5*)

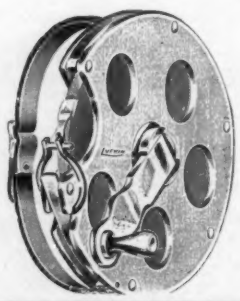
whatever they could find, and in any event it was only the very exceptional *and lucky* man, or one who possessed some private capital, who ever got very high in a professional way. In a few cases which came under my knowledge, the men, after whatever experience they could get here, went back to their own countries and there were taken on by companies which sent them out again. But, alas, times have changed. World conditions today are such that any similar action is too hazardous to be thought of.

It follows, then, that if anyone really hopes to work in this country, he must secure his employment beforehand, and it goes without saying how valuable, both in getting the job as well as in holding it down, will be a good knowledge of Spanish. Clearly, too, some general commercial knowledge or experience is useful, and in the case of engineer-salesmen is imperative. As to technical training, a broad, general grasp of engineering principles is probably more useful than specialization.

Particularly if one is stationed outside of Buenos Aires or the other large cities will it be found that innumerable problems must be solved that in a more industrially developed country would be submitted to specialists. If you are the "ingeniero" you are expected to have a complete mastery of plumbing, furniture making, metallurgy, radio-telephony, calculating machines, and Heaven only knows what else. However, one hint may be given: There is going to be more and more manufacturing done here in the future and hence, whatever may be the job for which one comes out, it is well to be interested in factory organization, manufacturing processes, industrial chemistry, etc., rather than in any special subject.

Made To Measure





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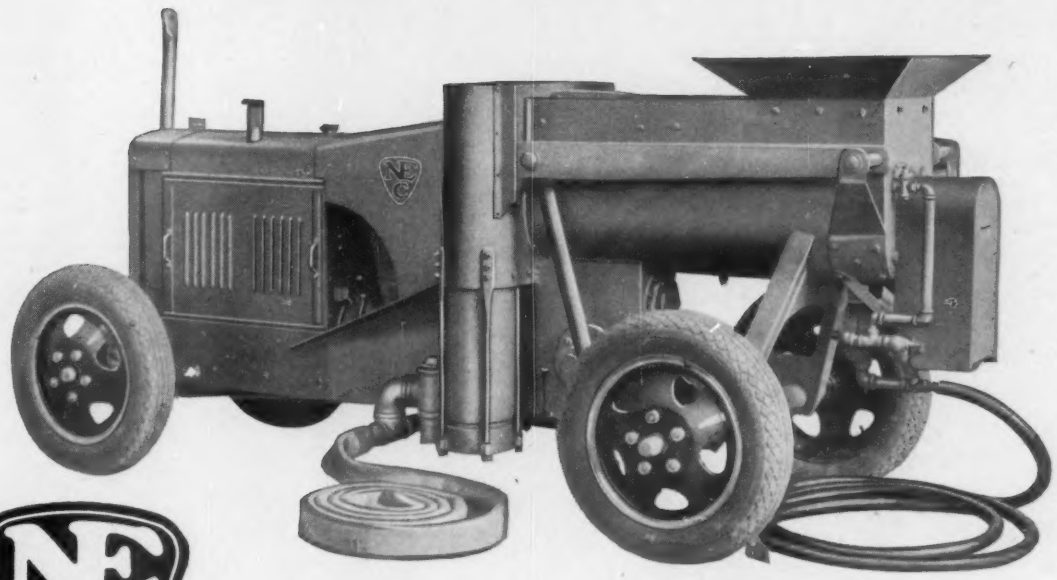

The principle of operation of the Mud-Jack is based upon the well known law of hydrostatics that "pressure is exerted with equal intensity in all directions". It is the same principle which is applied in the operation of hydraulic elevators or pneumatic lifts. A pressure of 1 lb. per sq. in. exerted by the machine is more than sufficient to raise the pavement. Higher pressures are sometimes necessary first to pry the slab loose from the subgrade.

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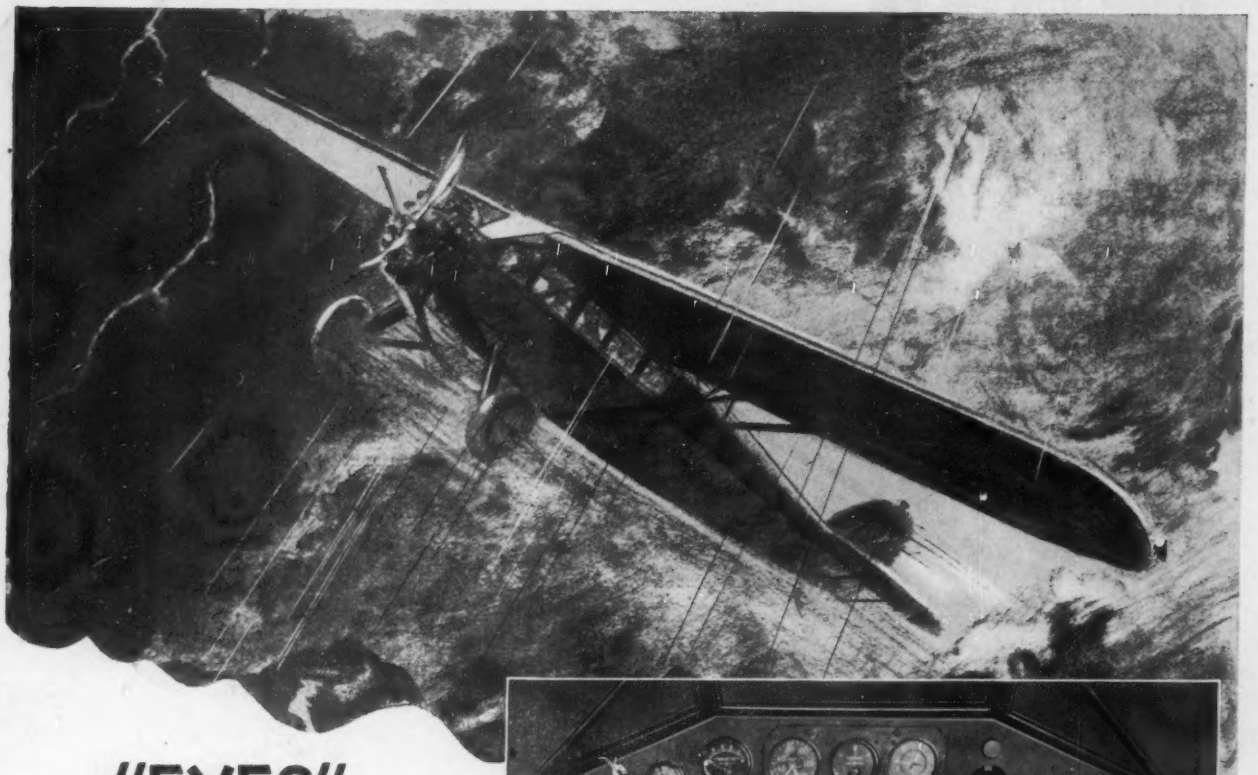

"EYES" THAT GUIDE AIRCRAFT

SPEED with safety and dependability is the essence of airplane service. To-day's ship is safer in fog and darkness. Its "eyes" are in its instruments, and the equipment of a new monoplane recently purchased by General Electric is unique in that the instrument panel is almost completely electrified.

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